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Virtual reality in the automotive industry: Should car dealerships adopt VR on a large scale to enhance the customer experience?

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Abstract

The potential application of virtual reality (VR) technology in the automotive industry is still under investigated, especially in the context of retail. This study aims at filling the research gap by utilizing a consumer survey and car dealer questionnaire to analyse the attitude toward VR devices in the given context and learn about potential applications. The primary research revealed that both consumers and professionals working in the industry have an overall positive attitude toward the use of VR headsets and that its adoption would entail numerous benefits, one of them being a more enjoyable and efficient customization experience.

Keywords: Virtual Reality, Automotive Retail, Customization Experience, UTAUT

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1 Introduction

"Imagine if every purchase journey was entirely unique to each individual customer, with relevant content delivered directly to their fingertips" (de Bodinat, 2018). According to François de Bodinat, CMO at the firm ZeroLight which is specialized in creating digital platforms for the car industry, the future of automotive retail entails a much higher degree of personalization than is currently known. Marketers all around the world seem obsessed with personalizing and improving the customer experience. The automotive sector, which still seems to be old fashioned compared to others, may see in the future massive changes in the way it interacts with its customers. The use of virtual reality and related technologies is one way how this turnaround may be achieved. This paper is concerned with analysing the potential use of virtual reality (VR) technology at showrooms of car dealerships to enhance their customers' experiences. Currently, only some original equipment manufacturers (OEMs) have adopted VR technology on a smaller scale to enable potential customers to experience their product portfolio virtually. There has already been some research done that analyses the general acceptance of VR, however, not in an automotive context. This qualitative research will attempt to fill the research gap and utilize primary data to ascertain whether car dealerships in general should familiarize themselves with the opportunities that the use of VR has to offer and perhaps consider an adoption on a larger scale.

2 Literature Review

2.1 Virtual Reality

Virtual Reality is "a form of immersive digital media that generates a three-dimensional, virtual imaginary and interactive media environment that the user processes or perceives much as he/she perceives the real world. This allows a user to process virtual visual stimuli and navigate realistically within a virtual environment; for example, applications often enable a user to look

around or navigate through a virtual environment" (Herz & Rauschnabel, 2018, p.229). In order to experience VR, one needs to utilize a VR headset (also called VR glasses). It allows individuals to use immersive VR applications and enables them to experience (through inbuilt screens and speakers) and interact (through the use of controllers) with simulated environments through a first-person perspective (ibid).

The term VR first appeared in the 1960s. Nonetheless, the price of VR equipment was rather high and thus it was only used in specific fields such as medicine, defense, and education. In recent years however, VR technology has evolved drastically and with more affordable commercial equipment entering the market, especially for entertainment purposes such as gaming, VR has received considerable attention from consumers (Lee et al, 2018, p.38). According to IDC, a market analysis agency, sales of VR headsets are to reach approximately 8 million units for the year 2019. Sales figures are expected to grow tremendously and reach 36.7 million units in 2023 (IDC, 2019). An example for a commercially avaible VR device is the Oculus Quest, which can be seen in *appendix 1*. The firm behind the device is Oculus VR. It was founded in 2012 and bought in 2014 by Facebook for approximately $ 2 billion USD. Oculus VR can be seen as the leader in immersive virtual reality technology (Facebook, 2014).

Another term that is often used in combination with VR is augmented reality (AR). It is a related yet distinct concept. "In contrast to VR, users of AR are not closed off from reality. Rather, AR augments the perception of the real world by overlaying virtual elements on top of it" (Herz & Rauschnabel, 2018, p.229). An example of such an AR device would be Google Glass' latest product, the Glass Enterprise Edition 2 (*appendix 2*). Overall, worldwide sales of products and services related to VR and AR are expected to increase from $5.2 billion in 2016 to more than $162 billion in 2020 (Lee et al, 2018, p.38).

VR is not unfamiliar to the automotive industry. It is already applied on a wide scale across different manufacturers in the areas of desgin as well as employee training. *Appendix 3* depicts an employee at a Porsche traning center utilizing a VR headset and a pair of controllers to familiarize himself with the electrical powertrain of a Porsche hybrid model. The employee views through the headset a 3D model of the vehicle and can engage with the model and remove components of it to unveil underling technical components. In a similar fashion, this technlogy is also used when designing a vehicle. *Appendix 4* shows an employee using VR technology to experience and test the ergonomics of the interior of a newly developped concept car. The advantages of applying VR in the mentioned fields are versatile. This technology enables employees to train on vehicles long before they are actually available. Furthermore, they can train in a safe environment (training with genuine high-voltage cables is dangerous) and simulations in VR are less costly and easier to conduct (Günzler et al, 2018).

In recent years, VR has also been used in a marketing and retail context. Audi is one of the first brands to introduce this technology at its dealerships. In 2015, Audi tested its application at selected dealerships in Germany and Brazil. Since then, VR has been introduced at several dealers in Germany, the United Kingdom, and Spain, with further expansions planed (Audi Media Center, 2017). The use of a VR Headset in the context of retail can be seen in *appendix 5*, where a customer can experience his interior configurations of a selected model at an Audi dealership. Furthermore, to exemplify the use of VR for marketing purposes, one can look at Porsche's use during the Slush 2017 event (a non-profit tech and start-up event hosted in Helsinki). Porsche partnered up with ZeroLight to use VR to enable visitors to experience an electric concept car from Porsche, the Mission E (the car has recently been introduced to the market as the Porsche Taycan) (ZeroLight, 2017).

2.2 Related Research on Virtual Reality

Since VR has only been commercially available for a few years now, literature on this topic is scarce. While there are numerous research and consulting institutions that highlight the potential consumer applications, scientific knowledge remains limited, especially in the context of the automotive industry. Most of the academic literature to date deals with the general acceptance of VR hardware and factors influencing the attitude toward it, including Herz and Rauschnabel (2018) or Manis and Choi (2018). Both papers utilized structural equation modeling to measure the realtionship between the measured variables, for this purpose, the latter paper also applied an adapted version of the Technology Acceptance Model (TAM). Herz and Rauschnabel (2018) reveal that the surveyed consumers overall had a positive attitude toward using VR headsets. They especially tend to react positively if they assosciate them with hedonic benefits, although most surveyed consumers do not see a functional value in the technology nor find the desgin of today's VR devices convincing. Manis and Choi (2018) have similar findings, revealing that a consumer's perception of usefulness, enjoyment, and ease of use are positive predictors of the attitude toward using and purchasing VR hardware. Perceived enjoyment emerged as the most powerful preditor relative to the other variables, indicating again the importance of hedonic benefits.

In addition, some research deals specifically with older adults' acceptance of VR and the related hardware. To exemplify, Restorick Roberts et al (2018) conducted focus groups with residents of a retirement community and found that overall the acceptance and curiosity toward the tecnology are rather high, with some implications for the modification of the VR hardware to better suit the needs of elderly people. Moreover, research has been conducted in the areas of tourism (Wei, 2019) (Beck et al, 2018), education (Shen et al, 2018) (Huang et al, 2016) (Chang et al, 2019), and sports (Stinson & Bowman, 2014) (Michalski et al, 2019), indicating the versatile application opportunities of VR. One of the few studies that have been conducted in

an automotive context analysed the current use of VR for manufacturing purposes and conducted interviews with employees at a British car manufacturer to detect opportunities for improvement (Lawson et al, 2015).

2.3 Applied Concepts and Frameworks

Understanding how people react to innovations, especially new technologies, has been thematised in numerous studies. Thus, there are multiple frameworks and models which attempt to explain this phenomenon. One of the most widely applied models of users' acceptance and usage of technology, is the Technology Acceptance Model (TAM) (*appendix 6*). The model was first introduced by Fred D. Davis in 1986 in his doctoral thesis for the Massachusetts Institute of Technology. It is an extension of the Theory of Reasoned Action (TRA) developed by Martin Fishbein and Icek Ajzen (1967).

According to the model, a potential user's overall attitude toward using a given system is based on two major fundamental and distinct beliefs: perceived usefulness and perceived ease of use. Perceived usefulness is defined as "the degree to which an individual believes that using a particular system would enhance his or her job performance". Perceived ease of use is defined as "the degree to which an individual believes that using a particular system would be free of physical and mental effort" (Davis, 1986, pp. 24-26).

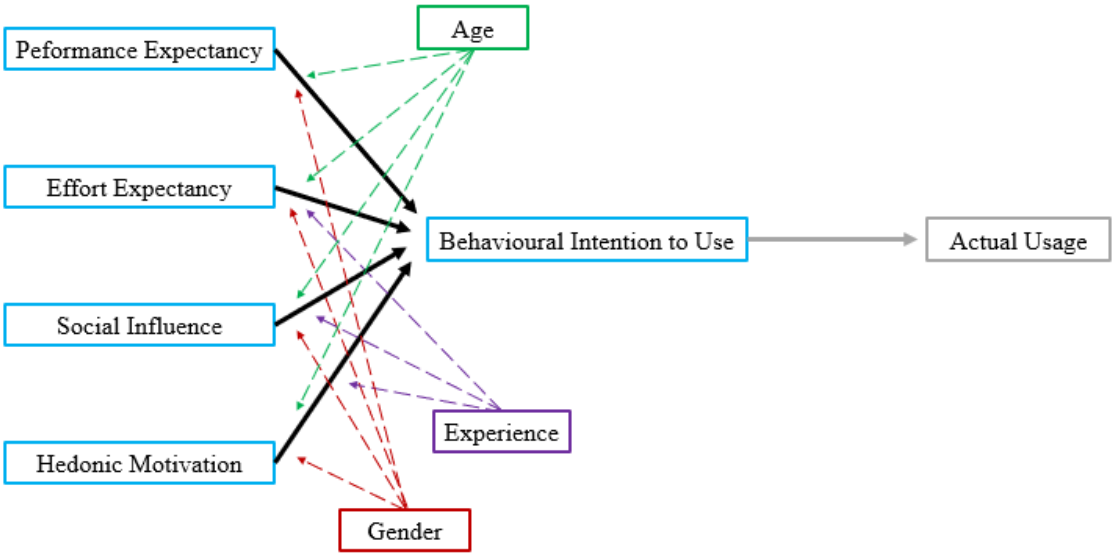
Furthermore, the original model has been continuously adapted since its introduction. The latest version, the TAM 3 (*appendix 7*) is a substantial progression from the original model and introduces additional variables which prove to have a direct effect on the perceived ease of use of a given technology. Viswanath Venkatesh, who is one of the developers of the TAM 2 and 3, introduced in 2003 along with others a further model called the Unified Theory of Acceptance and Use of Technology (UTAUT) (*appendix 8*). This model is partly based on the original TAM since it thematically adopts several of its variables such as perceived usefulness as well as

perceived ease of use and yet introduces two novel moderators which influence the relationships between the distinct variables (the new moderators being gender and age). The UTAUT is the precursor to the UTAUT 2, which was introduced in 2012 by Venkatesh, Thong and Xu.

The novelty that the latest model presents is that it can be seen as one of the first models to analyze the technology adoption from a consumers' perspective, unlike most models that do so from an organizational point of view, including the TAM and its extensions. The UTAUT 2 achieves this by introducing "key additional constructs and relationships to be integrated into UTAUT, thus tailoring it to a consumer use context" (Venkatesh et al, 2012, p. 158). Moreover, in the research conducted by Venkatesh et al. (2012), the UTAUT 2 explained the variance in both bahavioral intention and technology use by 74% and 52%, respectively. These results are similar to those obtained in Venkatesch et al.'s (2003) study of UTAUT in an organizational context (70% and 48% respectively). "This suggests that the proposed extentions are critical to making the predictive validity of UTAUT in a consumer context comparable to what was found in the original UTAUT studies in an organizational context" (Venkatesh et al, 2012, pp. 172-173). The model together with a definition of the constructs and relationships can be consulted in *appendix 9*.

Since this research deals with the analysis of the use of VR in a consumer use context, namely the use by consumers at car dealerships, the UTAUT 2 was chosen as a foundation for this work. However, an adapted version of this model will be used since, as will be explained, not all constructs and relationships are deemed necessary for the scope of this research. The figure on the following page depicts the model that will form the foundation of this research:

Figure 1 - UTAUT 2 Adapted



Source: Modified after: Venkatesh et al, 2012

The model above displays five main variables in conjunction with the three moderators proposed by the UTAUT 2. The arrows in bold imply that certain variables have an effect on others whereas the dotted arrows denote that the three moderator variables can influence the extent to which the main constructs can affect the "Behavioural Intention to Use". The variable "Actual Usage" is highlighted differently because it is not within the scope of this research to measure the actual usage of VR headsets at car dealerships. The main reasons therefore are that: Firstly, VR technology is still a novelty in the context of automotive retail and thus not yet applied on a large scale; Secondly, this research aims at measuring the attitude towards VR technology to make suggestions whether car dealerships should adopt it or not.

Compared to the original model, three variables are left out, the first being "Facilitating Conditions". This construct was removed because it measures consumers' perceptions of the resources and support available to utilize VR headsets. Since, generally speaking, consumers would face the same conditions in any car dealership (a VR headset and a trained sales representative to assist the customers), the construct is not required in this study. Additionally, the variable "Price Value" was removed since in this scenario consumers do not bear the

financial cost of using the technology because it will be provided by car dealerships free of charge. Lastly, the variable "Habit" was removed as well since, as has been already mentioned, the use of VR in automotive retail is still a novelty and not adopted on a large scale, thus making it impossible for consumers to have already become habitual users of VR headsets in the automotive context.

2.4 Hypothesis

The constructs "Performance Expectancy", "Effort Expectancy" and "Social Influence" are derived from the original UTAUT model which in turn captured the essentials from eight previously established models. The construct "Hedonic Motivation", often also conceptualized as perceived enjoyment, has been proven to be a key variable influencing the intention to use innovative devices such as VR headsets (Lee et al, 2018, p. 39). Furthermore, besides the evidence that perceived enjoyment has been found to influence technology acceptance and use directly, the UTAUT 2 has established that hedonic motivation is a critical determinant of behavioural intention and that it is in fact a more important driver than performance expectancy in non-organizational contexts (Venkatesh et al, 2012, p. 171). Thus, the establishment of the following hypotheses is sensible:

- H1: Performance expectancy will have a significant positive influence on the behavioural intention to use VR at car dealerships.
- H2: Effort expectancy will have a significant positive influence on the behavioural intention to use VR at car dealerships.
- H3: Social influence will have a significant positive influence on the behavioural intention to use VR at car dealerships.
- H4: Hedonic motivation will have a significant positive influence on the behavioural intention to use VR at car dealerships.

Venkatesh et al. (2003) established with the UTAUT that the effect of performance expectancy on the behavioural intention to use was moderated by gender and age in the way that the effect

was stronger among younger people, particularly men. The influence of effort expectancy was found to be moderated by gender and age (stronger among older women) as well as to be more significant when exposure to the technology was limited. Put differently, the effect decreased with increasing experience. Furthermore, social influence was proven to be moderated by age, gender, and experience. The effect was strongest among older women who were in the early stages of experience with the given technology (Venkatesh et al, 2003, p. 461). Lastly, the UTAUT 2 demonstrates that age, gender, and experience moderate the effect of hedonic motivation on behavioural intention such that the effect is stronger among younger men in early stages of experience (Venkatesh et al, 2012, p. 171). Thus, the following hypotheses are reasonable:

- H5: The effect of performance expectancy on the behavioural intention to use will be moderated by age and gender, such that the effect will be stronger among younger men.
- H6: The effect of effort expectancy on the behavioural intention to use will be moderated by age, gender and experience such that the effect will be stronger among older women in early stages of experience.
- H7: The effect of social influence on the behavioural intention to use will be moderated by age, gender and experience such that the effect will be stronger among older women in early stages of experience.
- H8: The effect of hedonic motivation on the behavioural intention to use will be moderated by age, gender, and experience such that the effect will be stronger among younger men in early stages of experience.

3 Methodology and Research Design

3.1 Measurement Model and Data Collection

As this research aims at measuring consumers' perceptions of VR technology in the context of automotive retail, an online survey was utilized to capture consumers' attitudes toward this innovation. The survey was created via Qualtrics. It was constructed in such a way that only

fully completed surveys could be submitted and that every respondent could only undertake it once. The items and the scales of the survey are adapted from prior research, the items together with their sources are included in *appendix 10*. The survey was designed in such a way that respondents who were not familiar with VR headsets received basic information about VR devices and how they function as well as were shown a picture of such a device in use. This ensured that all respondents had the necessary theoretical foundation to fill out the survey in a meaningful manner. The five main constructs were measured using a five-point Likert-scale with the anchors being "strongly disagree" and "strongly agree". A multiple-choice question was used to assess the different points along the customer journey where consumers could imagine themselves utilizing VR devices and a ranking question was used to gain insights into the most important criteria when purchasing a car. Lastly, the moderators were measured toward the end of the survey: Experience was measured as an estimate of the amount of times the respondents used VR devices by offering them four possible options to choose from, ranging from "never" to "frequent use". Age was measured in years by giving the respondents a blank space to fill in their age as a whole number and gender was measured by giving the consumers three possible options (male, female, and other).

The survey was reviewed by two university professors for content validity after which it was pilot tested with 26 participants who were not included in the sample of the main survey. The review and pilot test did not reveal any major concerns and were used to make some minor adjustments in the wording of some items and the scale of one item. The survey was then distributed by the author by directly approaching contacts via the social media platforms LinkedIn and Facebook as well as WhatsApp Messenger. This sampling technique, known as convenience sample, is not only simple to carry out but in this case also sensible since the majority of the author's contacts are rather young (below 30). This is essential because, as will be pointed out later, younger consumers (e.g. millennials) will form a substantial part of the

potential car buying clients in the future. Over 400 people were contacted which resulted in a total of 271 respondents. Of these recorded responses, several were identified as outliers due to the completion in an unreasonable amount of time (< 120 seconds) and thus removed from the final data set (including one response which was recorded within a period of over 48 hours). This adjustment leads to a total of 262 valid responses. The gathered data was analysed using the IBM software SPSS and Microsoft Excel. Additionally, structural equation modelling (SEM) was conducted via SPSS AMOS to test the validity of the model as well as the hypotheses. Since SEM is an essential part of this work and familiarity with it cannot be presupposed, it will be briefly explained in the next section.

Moreover, since this research relies on self-reported measures, common method variance (CMV) could be a threat to the results. The most common test to assess the CMV is the Harman's Single-Factor test. The test revealed a single factor loading of 28.75% which is substantially below 50%, thus indicating that CMV is not an issue in this research (Tehseen et al, 2017). Lastly, response bias was addressed by including two reverse worded items (EE4 and HM4). These items' scales were subsequently inverted in SPSS for the analysis. The Cronbach's Alpha values indicated that the removal of the affected items would lead to slight improvements in the overall scores. However, the items EE4 and HM4 clearly loaded onto one factor and their removal did not yield an improved model fit. This implies that the majority of respondents answered the survey carefully. Therefore, with the overall Cronbach's Alpha scores still being satisfactory (> 0.7), the concerned items remain in the dataset and will be included in the SEM.

Furthermore, a short questionnaire consisting of five questions was sent to selected professionals who work in the automotive sector since they are directly affected by the VR innovation in automotive retail. In particular, six employees of the German premium car manufacturer Porsche were contacted, four of which are sales representatives at dealerships in

the Austrian market. The remaining two employees work in management and are based in Switzerland and Austria. The consumer and dealer surveys are available in *appendix 11* and *12*, respectively.

3.2 Structural Equation Modelling

Structural equation modelling (SEM) is a multivariate statistical analysis technique. It is, for instance, a very popular tool in the area of marketing research. In this field, personality traits, attitudes and opinions play an important role as drivers of consumer behaviour. These drivers are latent constructs, meaning that they cannot be observed or measured directly. Thus, one can only make inferences about them from what can be measured, such as responses to a survey, for example. Measuring such latent constructs is complex and one must also take measurement error into consideration. It is exactly here where SEM is a useful tool (Gray, 2017). It combines factor analysis and regression and "enables the researcher to simultaneously examine a series of interrelated dependence relationships among the measured variables and latent constructs (variates) as well as between several latent constructs" (Hair et al, 2014, p. 546). In other words, SEM will allow the author of this research to analyse the relationships between the five main constructs as well as the effects of the moderators on these key relationships. There are several software tools that enable or facilitate SEM, SPSS AMOS is one of them.

4 Research Findings

4.1 Sample Characteristics

The 262 respondents are perfectly distributed in terms of gender (50% male, 50% female). The youngest respondent is 17 years of age, the oldest 72. The mean age is 25.4 years and the median age is 24 years. As expected, the overall sample is rather young with 75% of respondents being 25 years of age or younger. 80.2% of the sample population have heard of VR headsets before,

half of which (47.3%) are familiar with the way these devices function. 60% of the respondents have used a VR device at least once, indicating that a large part of the sampled population (40%) have not yet experienced VR technology. Of the consumers that have already experienced VR technology, 9 (3.4%) own such a VR device. However, 24 (9.2%) have the desire to own such a device and 131 (50%) might potentially own one in the foreseeable future. The detailed frequency tables are in *appendix 13*.

4.2 Measurement Validation

To validate the reflective scales, several tests and analyses were conducted. An exploratory factor analysis revealed that the survey items represent five main constructs. This result is desirable since it reveals that the constructs of the model can also be found in the survey data. *Appendix 14* depicts a scree plot where the five constructs clearly exceed the threshold Eigenvalue of one. In addition, the factor analysis revealed that one item, namely PE4, loaded onto two factors. Since such cross-loadings can impair the analysis, this item was dropped and not taken anymore into further consideration. *Appendix 15* displays the factor loadings of the remaining survey items. The factor analysis indicates that the respective items clearly load onto one factor. Moreover, the loadings were improved after the removal of item PE4. Additionally, the item SI3 was dropped as well. The reason therefor being that its removal does not only substantially improve the internal reliability of the items concerned but also improves the significance of some of the key relationships in the model. The rotation method used in *appendix 13* was Promax since it yielded the clearest results. Nonetheless, several extraction methods were used and all of them revealed distinct and unambiguous factor loadings.

Besides using factor analysis to ensure convergent validity, composite reliability (CR) and average variance extracted (AVE) were computed for each construct. The results exceed the required thresholds of 0.7 for CR and 0.5 for AVE (Hair et al, 2014, p. 605), indicating

satisfactory convergent validity. In order to ensure internal reliability, Cronbach's Alpha values were computed. The required minimum value of 0.7 is exceeded by all of the constructs (Hair et al, 2014, p. 123). The values for reliability and convergent validity are summarized in *appendix 16*. Regarding discriminant validity, all correlations among the factors are below the respective AVE values, implying satisfactory discriminant validity (*appendix 17*) (ibid, p. 605).

There are numerous model fit measures that can be used to assess whether a model is an adequate representation of selected data and hypothesized relationships. The most accepted and commonly used indices are the χ^2/df ratio, Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Normed Fit Index (NFI), Incremental Fit Index (IFI), and Root Mean Square Error of Approximation (RMSEA). The model including the moderators achieved a χ^2/df ratio of 1.457, a CFI of 0.927, a TLI of 0.909, an NFI of 0.805, an IFI of 0.929 and a RMSEA of 0.024. All of the stated fit measures are in line with the recommendations of literature, implying that the overall fit of the research model is adequate (Hair et al, 2014, pp. 576-584). These values are summarised again in *appendix 18*. These indices were also computed for the same model with the moderators excluded. Most measures improved slightly except for the χ^2/df ratio (1.762) and the RMSEA value (0.054).

4.3 Measurement Model Results

The results from the structural equation model (SEM) analysis are summarized in *appendix 19*. H1 is supported since performance expectancy has a significant ($p < 0.05$) positive influence on the behavioural intention to use VR at car dealerships. Effort expectancy is also proven to have a positive influence ($p < 0.05$) on the behavioural intention to use, which supports H2. Social influence is found to have a minor positive influence, but since the results are significant ($p < 0.05$), H3 is supported. Apart from that, hedonic motivation is revealed to have the strongest positive and significant ($p < 0.001$) influence from all of the constructs, thus H4 is

supported. Regarding the roles of the moderators, the results are less conclusive. The moderation effects of age and gender on the path between performance expectancy and intention to use are insignificant ($p > 0.05$), thus H5 cannot be supported. Furthermore, although the three moderators appear to influence the effect of effort expectancy on the intention to use, the chi-square test revealed that the chi-square values of the respective paths are below the critical values, thus H6 must be rejected. H7 must be rejected as well since all three moderators do not achieve significant ($p > 0.05$) paths between social influence and the intention to use. Lastly, all of the moderators achieved significant ($p < 0.05$) results for the path from hedonic motivation to the behavioural intention to use. As stated in H8, the effect is stronger among men compared to women and also stronger in early stages of experience (compared to respondents who have never used a VR headset before). However, since the effect is stronger among older people (contrary to the hypothesis), H8 can only be partly supported.

4.4 Discussion

It has been established that the model is valid and that the main constructs positively influence the behavioural intention to use VR at car dealerships. The next step is to analyse consumers' perception of this innovation and whether they intend to use it. The descriptive statistics in *appendix 20* reveal that the consumers in the sample view VR headsets to be a useful tool at dealerships (the mean answers for the items range from 4.03 to 4.05). Moreover, they view VR headsets to be rather easy to use, with the mean answers ranging from 3.56 to 4.03 for the respective items. Additionally, the respondents seem to predominantly have people in their social environment who have already gathered some experience with VR headsets. Regarding hedonic motivation, also termed as perceived enjoyment, consumers clearly view the use of VR devices at dealerships as enjoyable and exciting (mean scores range from 4.00 to 4.38). Lastly, the surveyed consumers have the behavioural intention to use VR devices in the foreseeable

future, especially in the automotive context. The mean scores for the items concerned range from 3.29 to 4.11. In sum, the consumers appear to have an overall positive attitude toward VR devices in the context of automotive retail as well as have the intention to use this innovation in the near future.

Regarding the dealerships, the questionnaires revealed some interesting insights (*appendix 21*). Overall, the respondents have a positive attitude toward the use of VR devices. They argued that the use of VR devices would enhance the configuration and customization experience for their customers. VR headsets would not only enable them to view the vehicles in 3D (compared to 2D on screens or in catalogues), but also to view every possible customization feature. Car dealerships usually have some samples of the different materials and optional extras for the customers to look at, but it is simply impossible to have a sample of every customization feature on hand. Using VR devices, clients will have instant access to all of the possible customization features and can view them as part of the complete interior or exterior of the car. Consequently, this also reduces the need for dealerships to have many different cars and samples in the showroom to show their customers the numerous different configuration options, allowing dealers to reduce their storage costs and to utilize their showroom space more effectively. All respondents highlight the improved visualization of the interior and exterior of the cars by using VR devices. These findings also coincide with the one's from the consumer survey. Consumers were asked for which purposes they would utilize VR headsets at car dealerships. 80% of consumers would use VR when customizing the interior and over 60% when customizing the exterior of the chosen model.

In addition to that, VR would allow dealerships to expand the offerings for their customers even further. Three respondents mentioned the possibility to simulate driving experiences through VR headsets. Whereas such simulations might not replace actual test drives, they may supplement the overall experience by allowing customers to experience the entire product

portfolio efficiently and help them to decide on a specific model. They could then finalize their decision by taking the chosen model for a test drive. This idea is also in line with the findings from the consumer survey, with almost 50% of the sampled consumers indicating that they would use VR devices to help them choose a specific car model. In that regard, two consumers also stated the possibility of using the devices for virtual driving simulations.

Furthermore, the use of VR headsets is not limited to car dealerships. As one of the sales representatives mentioned in the dealer questionnaire, VR devices could also be used at events such as car fairs and exhibitions. Moreover, as has been mentioned in the second chapter, VR technology can also be used in urban pop-up stores, thus bringing the product portfolio directly to the consumers. Many brands are experimenting with the concept of pop-up stores, since, in conjunction with VR headsets, a limited amount of space in a densely populated urban area can be used to present the entire product portfolio of a given brand to a large set of interested consumers and potential customers. Lastly, the respondents also mentioned some concerns. VR devices must be easy to use and must offer a high-quality resolution. The ease of use aspect is sensible and very important since the SEM analysis revealed that effort expectancy (ease of use) has a positive direct influence on the intention to use VR headsets. Current VR devices already offer a very good image and sound quality compared to early devices a few years ago. With VR devices still being a novelty, it is only reasonable to assume that the quality will even improve further within the coming years. Concluding the analysis of the dealer questionnaire, all respondents are in agreement about the potential benefits, with five out of the six of them having the desire to implement VR headsets in their showrooms.

Another important aspect to consider is the playful manner in which consumers can interact with VR devices. 50% of the surveyed consumers would use VR devices at dealerships also out of curiosity and not only when purchasing a new car. VR headsets allow consumers and potential buyers to interact playfully with a car brand and as such become aware of certain

brands or new models even before the need to purchase a new car arises. Therefore, VR devices could become a powerful tool for automotive brands to increase their brand awareness and as such draw in more prospective customers into their dealerships. These findings are also highlighted by the fact that hedonic motivation (perceived enjoyment) is found to have the strongest positive influence on the intention to use VR devices. This corresponds with other, similar research, as well (Manis & Choi, 2018) (Lee et al, 2018). The mentioned statistics are displayed in *appendix 22*.

In addition to that, should autonomous vehicles become a reality in the near future, VR devices will prove to be of an even greater value. Autonomous vehicles will enable their interiors to be designed in such a way that they mimic a living room or an office, for instance. The reason therefor being that self-driving cars will no longer need operation controls (steering wheel etc.) and can thus be designed to become a "personally tailored platform for increased productivity and entertainment, [where] the dominant customer value driver becomes the capability for customized configuration and personalization" (Dinsdale et al, 2016, pp. 5-6). Examples of such autonomous vehicles are displayed in *appendix 23*. With endless customization options, VR devices have the potential to become the best means of showcasing the infinite personalization possibilities.

Another aspect that might become relevant in the future is the supply of VR media on the websites of automotive brands. From the surveyed consumers, only 9 of them (3.4%) own a VR headset. However, 10% indicated that they have the desire to own a VR device in the future and 50% stated that they might do so as well. With the potential of VR devices to substantially increase their penetration rates at consumer households within the coming years, car manufacturers might consider offering VR online car configurators as well as other VR adapted media. In fact, several brands are already offering some VR adjusted media on their websites.

Therefore, car dealerships might cooperate with their respective OEMs to extend their VR offerings, perhaps even into the households of their customers.

4.5 Limitations and Future Research

The present study is subject to several limitations. The most substantial limitation is the overall young sample, with an average age of 25. Although millennials are expected to represent over 45% of the potential car-buying cohort in 2025 (Fanderl et al, 2019), it is still paramount to understand the attitudes toward VR devices of older generations as well. The young sample is most likely the reason for the insignificance of most of the moderation effects of age, since people who were grouped in the "old" group could still be viewed as being part of the younger group (ages in the "old" group ranged from 24 to 72). For the hypotheses testing it would have been very interesting to see how the interaction between the constructs would have changed if all four different experience levels would have been represented more or less equally (only one respondent was a frequent user). Thus, future research should try to incorporate more frequent and habitual users. Another interesting aspect would be to analyse the actual use of VR devices at car dealerships and how attitudes toward this innovation change after the first usage. Such a study would need to be conducted jointly with an appropriate car dealership over a longer period of time. Lastly, the dealers and management employees who filled out the questionnaire are from a premium car manufacturer. Naturally premium brands are the early adopters of such resource intensive innovations. Nevertheless, it would be very interesting to conduct a similar study with other manufacturers as well.

5 Conclusion

To the best of the author's knowledge, this is the first study that was conducted at the intersection of VR use in the context of automotive retail and academic research. This research provides early insights into consumers' perceptions of this novel media technology and analysed its potential use at car dealerships. An adapted version of the UTAUT 2 model was used as the theoretical foundation of this paper. SEM revealed that the adapted model had an adequate fit and proved that the main hypotheses were supported, implying that the measured constructs positively influence consumers' intention to use VR devices. Furthermore, the surveyed consumers have an overall positive attitude toward VR headsets and have the desire to utilize this technology to facilitate and enhance their experiences at car dealerships. The surveyed dealers have as well a positive attitude and see many benefits that this innovation could bring to them and their customers. The results of this study suggest that automotive dealerships should implement VR devices in their showrooms to enhance their customers' experiences and facilitate the personalization process. The most important aspects that must be considered here are hedonic motivation and effort expectancy. Therefore, should this technology be utilized, it must be ensured that it is easy to use and an overall enjoyable experience.

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7 Appendix

Appendix 1

The image shows the Oculus Quest headset with two controllers. The model was introduced in spring 2019 with a starting price of $399 USD.

Source: Facebook, 2018.

Appendix 2

Glass Enterprise Edition 2 with safety frames.

Source: Google, 2019.

Appendix 3

Source: Günzler et al, 2018, pp. 34-37.

Appendix 4

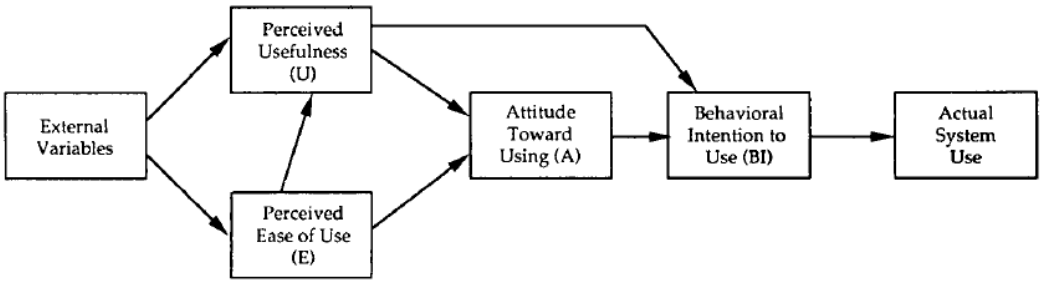
Source: Doerk & Winterhagen, 2017, p. 53.

Appendix 5

Source: Audi Media Center, 2017.

Appendix 6

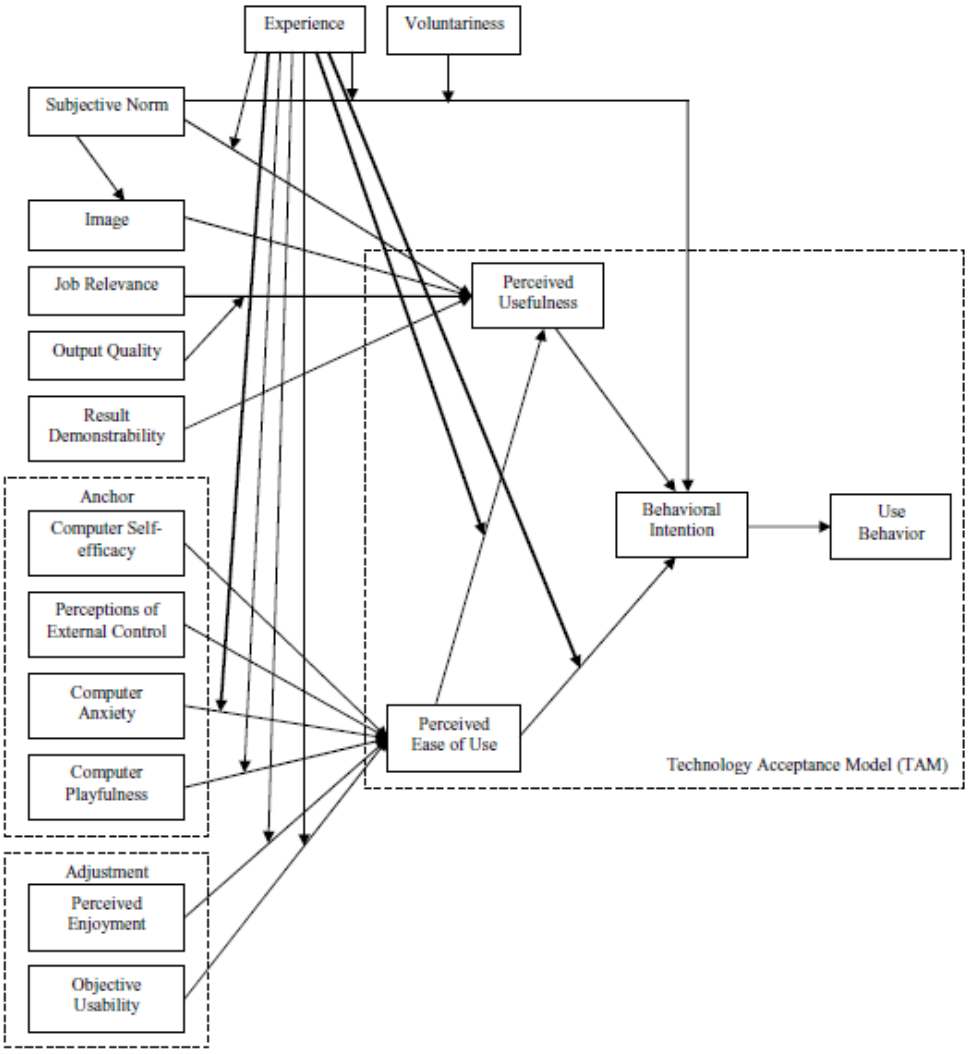
Technology Acceptance Model



Source: Davis et al, 1989.

Appendix 7

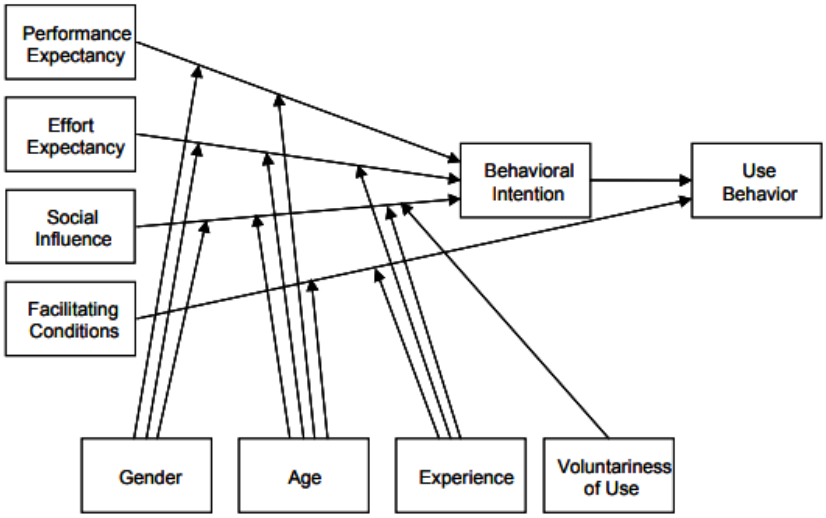
Technology Acceptance Model 3



Source: Venkatesh & Bala, 2008.

Appendix 8

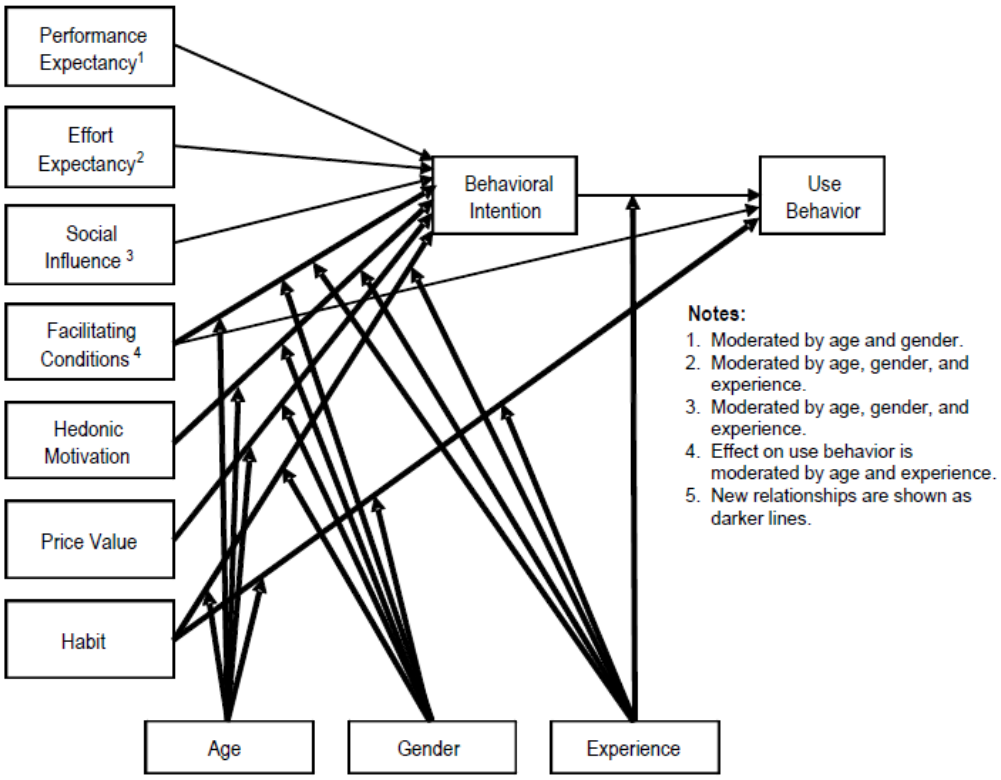
UTAUT



Source: Venkatesh et al, 2003.

Appendix 9

UTAUT 2



Source: Venkatesh et al, 2012.

Definition of constructs and moderators:

Construct	Definition
Performance Expectancy	The degree to which using a technology will be provide benefits to consumers in performing certain activities.
Effort Expectancy	The degree of ease associated with consumers´ use of technology.
Social Influence	The extent to which consumers perceive that important others (e.g. family and friends) believe they should use a particular technology.
Facilitating Conditions	Consumers´ perceptions of the resources and support available to perform a behaviour.
Hedonic Motivation	The fun or pleasure derived from using a technology.
Price Value	Consumers´ cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them. The price value is positive when the benefits of using a technology are perceived to be greater than the monetary cost.
Habit	The extent to which people tend to perform behaviours automatically because of learning. In this context, habit is a perceptual construct that reflects the results of prior experiences.
Behavioural Intention	The intention to use a given technology.
Use Behaviour	The actual usage of a given technology.
Age	Acts as a moderator and influences the extent to which a construct can influence another.
Gender	Acts as a moderator and influences the extent to which a construct can influence another.
Experience	Defined as the passage of time from the initial use of a technology by an individual. Or, in other words, the duration or amount of interaction with a given technology. Experience acts as a moderator and influences the extent to which a construct can influence another.

Source: Venkatesh et al, 2012.

Appendix 10

Consumer survey items:

Construct	Item	Measurement Items	Sources
Performance Expectancy	PE1	VR will allow me to explore different car models efficiently	Lee et al, 2018; Manis & Choi, 2018; Venkatesh et al, 2003
	PE2	Exploring the various vehicles through VR is useful	
	PE3	It is convenient to acquire information through VR	
	PE4	It is beneficial to view the different personalization options of the cars through VR	
Effort Expectancy	EE1	Operating a VR headset is simple	Lee et al, 2018; Venkatesh et al, 2012; Manis & Choi, 2018; Venkatesh et al, 2003
	EE2	Using VR devices does not require much training	
	EE3	I believe using VR hardware would be clear and understandable	
	EE4	Learning to operate a VR device would be difficult for me	
Social Influence	SI1	I know people who have used a VR headset	Venkatesh et al, 2012; Venkatesh et al, 2003
	SI2	I have friends who have experience with a VR device	
	SI3	People whose opinions I value think positively of VR technology	
Hedonic Motivation	HM1	Experiencing the different car models with VR would be fun	Herz & Rauschnabel, 2018; Lee et al, 2018; Venkatesh et al, 2012; Manis & Choi, 2018
	HM2	I would enjoy viewing the different personalization options through VR	
	HM3	I believe I would find using VR at car dealerships enjoyable	
	HM4	Experiencing cars through VR hardware would be boring	
Behavioural Intention to Use	BI1	I intend to use VR headsets in the future	Lee et al, 2018, Venkatesh et al, 2012; Manis & Choi, 2018; Venkatesh et al, 2003
	BI2	When entering a car dealership that provides a VR device, I intend to use it	
	BI3	There is a high likelihood that I will use VR hardware in the foreseeable future	
	BI4	I plan to use a VR headset when considering to purchase a new car	

Appendix 11

Online consumer survey:

Dear ladies and gentlemen,

Thank you for taking the time to participate in my survey and assist me with my Master´s thesis. This Survey should take you no longer than 5 minutes to complete.

All of the gathered data will be treated anonymously and confidentially.

Please click on the next page to begin.

→

Question 1

This survey is about the use of virtual reality (VR) headsets for the purpose of automotive retail. In particular, I am analyzing if car dealerships should install such VR headsets in their showrooms so that customers can experience and customize the cars virtually.

Have you heard of virtual reality headsets before?

Yes

No

Question 2

Are you familiar with the way that VR headsets function?

Yes

No

Displayed if “No” is selected

VR headsets are small computers that use integrated screens and speakers to send the user to another, virtual world. Through controllers and motion tracking technology the user can move around in this virtual world and interact with the environment. While wearing the VR headset, the user is completely cut off from the real world.

VR headsets have only been commercially available for a few years now. Consumers find them mainly in the area of entertainment, ex. gaming.

On the next page you can see an example of such a device in use.

Question 3

Please rate every statement according to your perception:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
VR will allow me to explore different car models efficiently	○	○	○	○	○
Exploring the various vehicles through VR is useful	○	○	○	○	○
It is convenient to acquire information through VR	○	○	○	○	○
It is beneficial to view the different personalization options of the cars through VR	○	○	○	○	○

Question 4

Please rate every statement according to your perception:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Operating a VR device is simple	○	○	○	○	○
Using VR devices does not require much training	○	○	○	○	○
I believe using VR hardware would be clear and understandable	○	○	○	○	○
Learning to operate a VR device would be difficult for me	○	○	○	○	○

Question 5

Please rate every statement according to your perception:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I know people who have used a VR headset	○	○	○	○	○
I have friends who have experience with a VR device	○	○	○	○	○
People whose opinions I value think positively of VR technology	○	○	○	○	○

Question 6

Please rate every statement according to your perception:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Experiencing the different car models with VR would be fun	○	○	○	○	○
I would enjoy viewing the different personalization options through VR	○	○	○	○	○
I believe I would find using VR at car dealerships enjoyable	○	○	○	○	○
Experiencing cars through VR hardware would be boring	○	○	○	○	○

Question 7

Please rate every statement according to your perception:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I intend to use VR headsets in the future	○	○	○	○	○
When entering a car dealership that provides a VR device, I intend to use it	○	○	○	○	○
There is a high likelihood that I will use VR hardware in the foreseeable future	○	○	○	○	○
I plan to use a VR headset when considering to purchase a new car	○	○	○	○	○

Question 8

For which parts of your purchase experience would you use VR in car dealerships?
(multiple answers possible)

- When assessing the different possible brands
- When considering which specific model to buy
- When customizing (interior) the chosen model to meet my expectations
- When customizing (exterior) the chosen model to meet my expectations
- I would use VR in car dealerships out of curiosity and not only when purchasing a new car
- Other:

Question 9

What do you value the most when purchasing a car?
(please rank the following items according to their importance to you)

- Product specifications (horsepower, Co2 emissions etc.)
- Product design
- Customer experience
- Product price

Question 10

Have you already used a VR headset in the past?

- No, never.
- Yes, once.
- Yes, several times.
- Yes, I use it frequently.

Question 11 (displayed if “No” is not selected)

Do you own a VR headset?

Yes

No

Question 12 (displayed if “No” is selected)

Do you plan on owning a VR device in the foreseeable future?

Yes

Maybe

No

Question 13

What is your gender?

Male

Female

Other

Question 14

How old are you?
(Please enter a whole number)

End

NOVA SCHOOL OF BUSINESS & ECONOMICS

We thank you for your time spent taking this survey.
Your response has been recorded.

Appendix 12

Dealer questionnaire

Nova School of Business and Economics, Portugal Odey Al-Omari

Dear ladies and gentlemen,

Thank you very much for taking the time to answer my short survey by which you assist me in writing my master´s thesis. The topic is the use of Virtual Reality (VR) headsets for automotive retail. I endeavour to find out whether car dealerships should utilize this technology on a large scale to enable their customers to experience and customize the vehicles virtually.

Besides conducting a survey with consumers, I would also like to hear the opinion of professionals working in the automotive industry. VR technology is already being used in the development and design process of automotive engineering. However, since a few years this technology can also be found in selected car dealerships. Audi (picture on the right) can be seen as one of the pioneers in that regard since they have already adopted VR in many dealerships worldwide. Porsche as well is familiarizing itself with VR: In Cooperation with ZeroLight Porsche enabled visitors of the start-up event Slush 2017 to experience the pre-production model of the Taycan through the use of a VR headset.

Name:

1) Do you have any professional experience with VR-devices?

2) Do you think that the use of VR headsets would be beneficial in car dealerships? In what ways could it assist you?

3) What do you think are possible applications of VR technology in the context of automotive retail?

4) Will you install VR headsets at your dealership? What are the major reasons for your decision?

5) Do you have any additional remarks about the use of virtual reality for automotive retail?

Appendix 13

Descritptive Statistics from SPSS:

What is your gender?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	131	50,0	50,0	50,0
	Female	131	50,0	50,0	100,0
	Total	262	100,0	100,0	

How old are you?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	17	2	,8	,8	,8
	18	9	3,4	3,4	4,2
	19	7	2,7	2,7	6,9
	20	12	4,6	4,6	11,5
	21	15	5,7	5,7	17,2
	22	22	8,4	8,4	25,6
	23	57	21,8	21,8	47,3
	24	29	11,1	11,1	58,4
	25	43	16,4	16,4	74,8
	26	20	7,6	7,6	82,4
	27	12	4,6	4,6	87,0
	28	3	1,1	1,1	88,2
	29	1	,4	,4	88,5
	30	3	1,1	1,1	89,7
	31	2	,8	,8	90,5
	32	3	1,1	1,1	91,6
	33	2	,8	,8	92,4
	34	2	,8	,8	93,1
	35	1	,4	,4	93,5
	36	3	1,1	1,1	94,7
	39	1	,4	,4	95,0
	40	1	,4	,4	95,4
	42	1	,4	,4	95,8
	43	2	,8	,8	96,6
	47	2	,8	,8	97,3
	48	1	,4	,4	97,7
	55	1	,4	,4	98,1
	57	1	,4	,4	98,5
	60	1	,4	,4	98,9
	62	1	,4	,4	99,2
	68	1	,4	,4	99,6
	72	1	,4	,4	100,0
	Total	262	100,0	100,0	

Have you heard of virtual reality headsets before?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	210	80,2	80,2	80,2
	No	52	19,8	19,8	100,0
	Total	262	100,0	100,0	

Are you familiar with the way that VR headsets function?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	124	47,3	59,0	59,0
	No	86	32,8	41,0	100,0
	Total	210	80,2	100,0	
Missing	System	52	19,8		
Total		262	100,0		

Have you already used a VR headset in the past?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No, never.	105	40,1	40,1	40,1
	Yes, once.	88	33,6	33,6	73,7
	Yes, several times.	68	26,0	26,0	99,6
	Yes, I use it frequently.	1	,4	,4	100,0
	Total	262	100,0	100,0	

Do you own a VR headset?

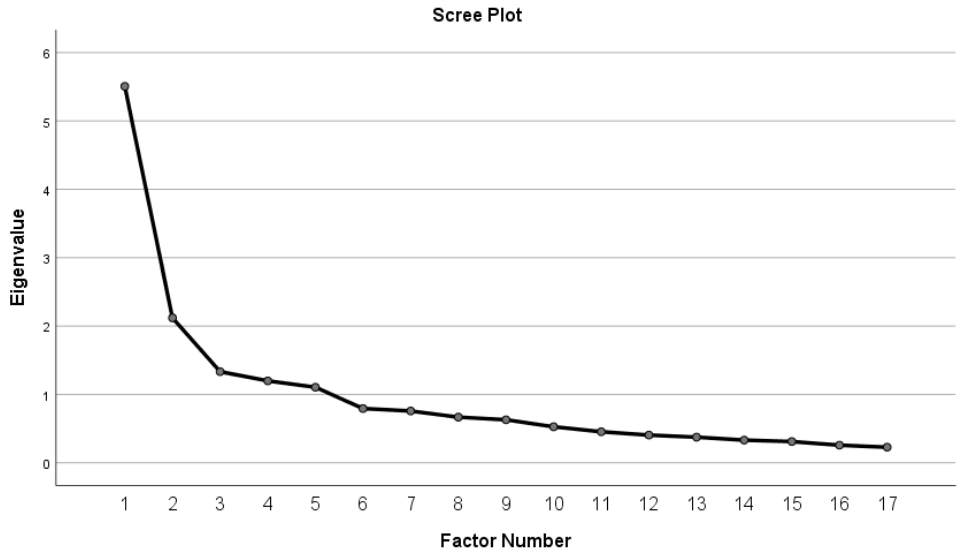
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	3,4	5,7	5,7
	No	148	56,5	94,3	100,0
	Total	157	59,9	100,0	
Missing	System	105	40,1		
Total		262	100,0		

Do you plan on owning a VR device in the foreseeable future?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	9,2	9,5	9,5
	Maybe	131	50,0	51,8	61,3
	No	98	37,4	38,7	100,0
	Total	253	96,6	100,0	
Missing	System	9	3,4		
Total		262	100,0		

Appendix 14

Scree plot generated in SPSS:



Appendix 15

Factor loadings generated in SPSS:

Pattern Matrix[a]

	Factor				
	1	2	3	4	5
HM_2	,876				
HM_1	,756				
HM_3	,597				
HM_4	,422				
EE_2		,862			
EE_1		,716			
EE_3		,708			
EE_4		,332			
BI_1			,744		
BI_3			,722		
BI_4			,562		
BI_2			,552		
PE_2				,937	
PE_1				,572	
PE_3				,416	
SI_1					,883
SI_2					,807

Extraction Method: Maximum Likelihood.
Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Note: Due to simpler detection of relevant factor loadings results below .30 are not displayed.

Appendix 16

Reliability and convergent validity:

Construct	Item	Cronbach's Alpha	Item-total Correlation	Factor Loading	CR	AVE
Performance Expectancy	PE1	0.717	0.563	0.572	0.700	0.633
	PE2		0.626	0.937		
	PE3		0.435	0.416		
Effort Expectancy	EE1	0.736	0.611	0.716	0.763	0.872
	EE2		0.634	0.862		
	EE3		0.607	0.708		
	EE4		0.321	0.332		
Social Influence	SI1	0.846	0.733	0.883	0.834	1.024
	SI2		0.733	0.807		
Hedonic Motivation	HM1	0.776	0.653	0.756	0.768	0.877
	HM2		0.693	0.876		
	HM3		0.635	0.597		
	HM4		0.395	0.422		
Behavioral Intention to Use	BI1	0.766	0.601	0.744	0.743	0.719
	BI2		0.576	0.552		
	BI3		0.618	0.722		
	BI4		0.483	0.562		

Appendix 17

Discriminant validity:

	1. PE	2. EE	3. SI	4. HM	5. BI
1. PE	**0.807**				
2. EE	0.308	**0.934**			
3. SI	0.237	0.376	**1.012**		
4. HM	0.609	0.239	0.238	**0.936**	
5. BI	0.556	0.388	0.305	0.610	**0.848**

Note: Diagonal elements in bold indicate the square root of the average variance extracted, the other parameters indicate the correlation (generated in SPSS) among the constructs.

Appendix 18

Model fit indices for model including moderators:

Model Fit Indices	
χ^2/df ratio	1.457
Comparative Fit Index (CFI)	0.927
Tucker Lewis Index (TLI)	0.909
Normed Fit Index (NFI)	0.805
Incremental Fit Index (IFI)	0.929
Root Mean Square Error of Approximation (RMSEA)	0.024

Appendix 19

Results of SEM in SPSS AMOS:

Hypothesis	Direction of Effect	Standardized Estimate	Unstandardized Estimate	SE	CR	P-value	Result
H1	PE ➡ BI	0.216	0.234	0.116	2.018	0.044	Supported
H2	EE ➡ BI	0.187	0.170	0.066	2.561	0.010	Supported
H3	SI ➡ BI	0.142	0.068	0.034	2.032	0.042	Supported
H4	HM ➡ BI	0.463	0.442	0.101	4.395	***	Supported

Note: ***p < 0.001

Results of SEM in SPSS AMOS (Moderators):

Moderator: Gender

Direction of Effect		PE ➡ BI	EE ➡ BI	SI ➡ BI	HM ➡ BI
Standardized Estimate	Male	Path is insignificant for both genders	Chi-Square value is below threshold	P-value for Women is insignificant, thus a comparison cannot be done	0.671
	Female				0.572
Unstandardized Estimate	Male				0.597
	Female				0.583
SE	Male				0.109
	Female				0.105
CR	Male				5.475
	Female				5.530
P-value	Male				***
	Female				***
Chi-Square			1145.053	1147.063	1163.503

Note: ***p < 0.001

Chi-square Test:

	Chi-square	df	p-value	Invariant?
Overall Model				
Unconstrained	1143,629	777		
Fully constrained	1240,01	867		
Number of groups		2		
Difference	96,381	90	0,304	YES
Chi-square Thresholds				
90% Confidence	1146,33	778		
Difference	2,71	1	0,100	
95% Confidence	1147,47	778		
Difference	3,84	1	0,050	
99% Confidence	1150,26	778		
Difference	6,63	1	0,010	

Moderator Age:

Direction of Effect		PE ➡ BI	EE ➡ BI	SI ➡ BI	HM ➡ BI
Standardized Estimate	Young	Path is insignificant for both age groups	Chi-Square value is below threshold	Path is insignificant for both age groups	0.568
	Old				0.684
Unstandardized Estimate	Young				0.517
	Old				0.691
SE	Young				0.103
	Old				0.112
CR	Young				5.038
	Old				6.185
P-value	Young				***
	Old				***
Chi-Square			1162.229		1179.911

Note: ***p < 0.001; In order to group the respondents into “Young” and “Old”, the median age (24) was computed. Everyone below 24 was grouped into “Young”, the rest was grouped into “Old”.

Chi-square Test:

	Chi-square	df	p-value	Invariant?
Overall Model				
Unconstrained	1161,308	784		
Fully constrained	1253,559	868		
Number of groups		2		
Difference	92,251	84	0,252	YES
Chi-square Thresholds				
90% Confidence	1164,01	785		
Difference	2,71	1	0,100	
95% Confidence	1165,15	785		
Difference	3,84	1	0,050	
99% Confidence	1167,94	785		
Difference	6,63	1	0,010	

Moderator: Experience

Direction of Effect		PE ➡ BI	EE ➡ BI	SI ➡ BI	HM ➡ BI
Standardized Estimate	Never	Path is insignificant for all experience levels	Chi-Square value is below threshold	Path is insignificant for all experience levels	0.408
	Once				0.741
	Several Times				0.780
Unstandardized Estimate	Never				0.305
	Once				1.171
	Several Times				0.700
SE	Never				0.086
	Once				0.254
	Several Times				0.162
CR	Never				3.551
	Once				4.602
	Several Times				4.334
P-value	Never				***
	Once				***
	Several Times				***
Chi-Square			1162.229		1179.911

Note: ***p < 0.001; Since only one respondent had the experience level of a frequent user, the data of this respondent was grouped together with the data of the respondents who have used VR devices “several times”.

Chi-square Test:

	Chi-square	df	p-value	Invariant?
Overall Model				
Unconstrained	1161,308	784		
Fully constrained	1253,559	868		
Number of groups		2		
Difference	92,251	84	0,252	YES
Chi-square Thresholds				
90% Confidence	1164,01	785		
Difference	2,71	1	0,100	
95% Confidence	1165,15	785		
Difference	3,84	1	0,050	
99% Confidence	1167,94	785		
Difference	6,63	1	0,010	

Appendix 20

Descriptive statistics from SPSS:

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PE_1	262	1	5	4,05	,796
PE_2	262	1	5	4,05	,825
PE_3	262	1	5	4,03	,875
Valid N (listwise)	262				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EE_1	262	1	5	3,56	,915
EE_2	262	1	5	3,62	1,013
EE_3	262	1	5	3,83	,780
EE_4	262	1	5	4,03	1,046
Valid N (listwise)	262				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SI_1	262	1	5	3,79	1,523
SI_2	262	1	5	3,77	1,455
Valid N (listwise)	262				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
HM_1	262	1	5	4,38	,857
HM_2	262	1	5	4,37	,856
HM_3	262	1	5	4,21	,867
HM_4	262	1	5	4,00	1,070
Valid N (listwise)	262				

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
BI_1	262	1	5	3,83	,907
BI_2	262	1	5	4,11	,885
BI_3	262	1	5	3,76	1,065
BI_4	262	1	5	3,29	1,025
Valid N (listwise)	262				

Appendix 21

Dealer questionnaire results:

Name: Jurik Becker (Porsche Switzerland AG)

1) Do you have any professional experience with VR-devices?

No I do not have yet.

2) Do you think that the use of VR headsets would be beneficial in car dealerships? In what ways could it assist you?

Yes, I think they could give both dealerships and customers a benefit.
The customer could experience both interior and exterior of his/her individually configured car, compare (in real time) fabrics/colors/features and have a better experience at the dealership.
This way, the dealership can utilize the created excitement of the customer to increase the relationship, have a higher influence on purchase decisions and at the end have a higher chance of selling a car with even higher average end prices.

3) What do you think are possible applications of VR technology in the context of automotive retail?

- Real time configurations (at dealerships)
- Showing test drive videos from inside the car (filmed by 360 degree cameras)

4) Will you install VR headsets at your dealership? What are the major reasons for your decision?

Rather yes. Reasons for a positive decision would be:

- Affordable solutions for car dealerships with preferably low effort to update the content.
- Easier convinced customers get more excited and are more likely to purchase a new car.
- To have competitive advantages on the automotive market.

5) Do you have any additional remarks about the use of virtual reality for automotive retail?

- Technology/devices should be easy to understand and use, so that every car dealership can use it (not only some dealerships).
- Updating the content needs to be made centralized (e.g. by manufacturer).
- The cost aspects and investments are (depending on the brand) rather important.

Name: David Pauler (Porsche Center Linz, Austria)

(Questionnaire was completed in German)

1) Hatten Sie bereits beruflich mit VR-Brillen zu tun?

Nein

2) Denken Sie, dass die Nutzung von VR-Brillen in Autohäusern nützlich wäre? Bitte listen Sie mögliche Vorteile auf.

Ja – Vorstellungsvermögen der Kunden wird unterstützt (Farbkombinationen etc.), Entscheidungsfähigkeit ist schneller gegeben, Emotion wird durch das Erlebnis verstärkt

3) Was wären Ihrer Meinung nach Anwendungsmöglichkeiten von VR-Brillen im Automobilvertrieb?

Konfiguration – Innenausstattung, Farbkombinationen, damit Design ersichtlich wird, Details besser erkennbar sind

4) Möchten Sie VR-Brillen in Ihrem Autohaus installieren? Was wären die Hauptgründe für Ihre Entscheidung?

Ja – man hat ein „reales“ Bild vor Augen, schnellere Kaufentscheidung, Kunden sehen meist nicht wirklich, welches Produkt in welcher Konfiguration sie kaufen – nur Darstellung in Car Configurator

5) Haben Sie noch irgendwelche Anmerkungen zum Thema „Virtuelle Realität“ im Automobilhandel?

Hygienethema – Brille ! gibt mit Sicherheit genug Kunden, die die Brille nicht aufsetzen möchten

Name: Stefan Möslinger (Porsche Austria Ltd.)

(Questionnaire was completed in German)

1) Hatten Sie bereits beruflich mit VR-Brillen zu tun?

Ja.

2) Denken Sie, dass die Nutzung von VR-Brillen in Autohäusern nützlich wäre? Bitte listen Sie mögliche Vorteile auf.

Ja:

- Virtuelle Präsentation des konfigurierten Wunschfahrzeuges: dabei kann jede einzelne Ausstattung – Interieur sowie Exterieur – mit jedem Detail erlebt werden
- Es müssen keine physischen Ausstellungsstücke (Fahrzeuge, Lack oder Interieur-Muster) vorhanden sein, es kann alles virtuell erlebt werden

3) Was wären Ihrer Meinung nach Anwendungsmöglichkeiten von VR-Brillen im Automobilvertrieb?

- Unterstützung bei der Konfiguration und Präsentation des Wunschautos
- Präsentation von Studien und Konzeptfahrzeugen
- Verkauf von Emotionen: zB VR-Cabriofahrt an einer Küstenstraße
- Experience von Erlebniswelten, zB Virtueller Rundgang im Porsche Museum

4) Möchten Sie VR-Brillen in Ihrem Autohaus installieren? Was wären die Hauptgründe für Ihre Entscheidung?

Ja, siehe Auflistung unter 3)

5) Haben Sie noch irgendwelche Anmerkungen zum Thema „Virtuelle Realität“ im Automobilhandel?

Wird in Zukunft eine wichtige Rolle spielen unter der Prämisse, dass die Qualität der VR von der Realität (fast) nicht mehr zu unterscheiden ist. Der Kunde muss das Gefühl haben, dass er sich wirklich gerade vorm oder im Fahrzeug befindet.

Name: Lars Jussek (Porsche Center Linz, Austria)

(Questionnaire was completed in German)

1) Hatten Sie bereits beruflich mit VR-Brillen zu tun?

Nein

2) Denken Sie, dass die Nutzung von VR-Brillen in Autohäusern nützlich wäre? Bitte listen Sie mögliche Vorteile auf.

Ausstattungsdetails kann sich der Kunde sofort ansehen

Kann sich das konfigurierte Fahrzeug sofort virtuell besichtigt werden

Lagerkostenersparnis – man braucht nicht mehr so viele Fahrzeuge zum Vorzeigen mit verschiedenen Ausstattungen

Personalisierte Demonstration

3) Was wären Ihrer Meinung nach Anwendungsmöglichkeiten von VR-Brillen im Automobilvertrieb?

Fahrzeugkonfiguration

Probefahrten virtuell durchführen

Events/Messen/Ausstellungen generell

4) Möchten Sie VR-Brillen in Ihrem Autohaus installieren? Was wären die Hauptgründe für Ihre Entscheidung?

Ja – professioneller Auftritt, Fahrzeugkonfiguration und Präsentation wird greifbarer für Kunden

5) Haben Sie noch irgendwelche Anmerkungen zum Thema „Virtuelle Realität" im Automobilhandel?

Eine hochwertige, qualitative Umsetzung ist unerlässlich – ansonsten eher gegenteiligen Effekt der genannten Vorteile, einfache Usability

Name: Oliver Hacker (Porsche Center Linz, Austria)

(Questionnaire was completed in German)

1) Hatten Sie bereits beruflich mit VR-Brillen zu tun?

Nein

2) Denken Sie, dass die Nutzung von VR-Brillen in Autohäusern nützlich wäre? Bitte listen Sie mögliche Vorteile auf.

Bessere Erlebbarkeit

Bessere Darstellung

Besser Visualisierung

Greifbarer für den Kunden

3) Was wären Ihrer Meinung nach Anwendungsmöglichkeiten von VR-Brillen im Automobilvertrieb?

Fahrzeugkonfiguration – innen außen + damit verbundene individuelle Abbildung der Kundenwünsche

4) Möchten Sie VR-Brillen in Ihrem Autohaus installieren? Was wären die Hauptgründe für Ihre Entscheidung?

Nein – für Premium Bereich nicht passend, besser eine eigene Lounge mit Visualiserung über Leinwand, Großbildschirm, Von Haus aus Brillenträger ausgeschlossen, Körperkontakt mit Kunden nicht so gut; Damen würden eher die Brille nicht aufsetzen

5) Haben Sie noch irgendwelche Anmerkungen zum Thema „Virtuelle Realität" im Automobilhandel?

Derzeit sehr gehyptes Thema, aber ich denke, der Endschritt wird sein dass Kleinsträume mit Projektionen der Kundenwünsche dargestellt werden; Besser Augmented Reality in einem eigenem Raum; VR Brillen schränken eher Sichtbereich ein.

Name: Ralf Kemetmüller (Porsche Center Linz, Austria)

(Questionnaire was completed in German)

1) Hatten Sie bereits beruflich mit VR-Brillen zu tun?

Nein bislang noch nicht.

2) Denken Sie, dass die Nutzung von VR-Brillen in Autohäusern nützlich wäre? Bitte listen Sie mögliche Vorteile auf.

Räumliches Vorstellungsvermögen würde gesteigert werden

Vorteil gegenüber relativ kleinen Farbmustern

Moderner Auftritt

3D Ansicht gegenüber 2D Ansicht

3) Was wären Ihrer Meinung nach Anwendungsmöglichkeiten von VR-Brillen im Automobilvertrieb?

Fahrzeugkonfiguration

4) Möchten Sie VR-Brillen in Ihrem Autohaus installieren? Was wären die Hauptgründe für Ihre Entscheidung?

Ja – Steigerung der Beratungskompetenz, Steigerung der Kaufkraft des Kunden

5) Haben Sie noch irgendwelche Anmerkungen zum Thema „Virtuelle Realität“ im Automobilhandel?

-

Appendix 22

Descriptive statistics concerning the potential applications of VR devices:

Statistics

		When assessing the different possible brands	When considering which specific model to buy	When customizing (interior) the chosen model to meet my expectations	When customizing (exterior) the chosen model to meet my expectations	I would use VR in car dealerships out of curiosity and not only when purchasing a new car	Other:
N	Valid	66	129	211	161	131	2
	Missing	196	133	51	101	131	260

When considering which specific model to buy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	When considering which specific model to buy	129	49,2	100,0	100,0
Missing	System	133	50,8		
Total		262	100,0		

When customizing (interior) the chosen model to meet my expectations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	When customizing (interior) the chosen model to meet my expectations	211	80,5	100,0	100,0
Missing	System	51	19,5		
Total		262	100,0		

When customizing (exterior) the chosen model to meet my expectations

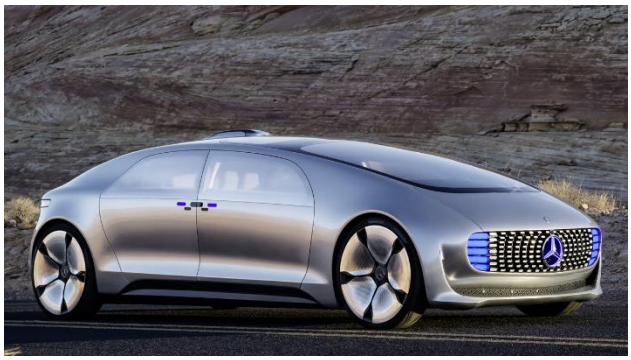
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	When customizing (exterior) the chosen model to meet my expectations	161	61,5	100,0	100,0
Missing	System	101	38,5		
Total		262	100,0		

I would use VR in car dealerships out of curiosity and not only when purchasing a new car

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I would use VR in car dealerships out of curiosity and not only when purchasing a new car	131	50,0	100,0	100,0
Missing	System	131	50,0		
Total		262	100,0		

Appendix 23

The Mercedes F 015, an autonomous vehicle (concept car):



Source: Kulalic, 2015.

The interior of the Mercedes F 015:

Source: Evon, 2015.

The interior of a concept car from Bentley:

Source: Miller, 2016.